AzCATI
Arizona Center for Algae Technology and Innovation

ASU Arizona State University

Algae Testbed Public Private Partnership (ATP^3): Enabling Algal Technology Research and Development

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Arizona Center for Algae Technology and Innovation (AzCATI)
at Arizona State University

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One little cell, a world of possibilities.

ATP3 Algae Testbed Public-Private Partnership

www.atp3.org

U.S. DEPARTMENT OF ENERGY

ATP3 Algae Testbed Public-Private Partnership

Vision

Establish a **sustainable network of regional testbeds** that empowers **knowledge creation** and **dissemination** within the algal R&D community, **facilitates innovation**, and **accelerates growth** of the nascent algal bioproducts and biofuels industry.

ATP^3 primary objectives

ATP^3 is a $15M Department of Energy (DOE) funded 5 year project led by ASU's Arizona Center for Algae Technology and Innovation (AzCATI).

Collaborative Open Testbeds

- Establish **network** of facilities for the algal research community and **increase stakeholder access** to real-world conditions for algal biomass production.
- **Accelerate** applied algae research, development, investment, and commercial applications for biofuel and bioproduct feedstock production.

High Impact Data from Long Term Algal Cultivation Trials

- Design and implement a unified experimental program across different **regional, seasonal, environmental and operational conditions** comparing promising production strains at meaningful scales.
- **Data made widely available** to the TEA/LCA and overall research community allowing for a robust analysis of the state of technology.

ATP³ Algae Testbed
Public-Private Partnership

ATP³ partners

AzCATI
Arizona Center for Algae Technology and Innovation

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Sandia National Laboratories

cellana
algae-based products for a sustainable future

CAL POLY
SAN LUIS OBISPO

Georgia Tech

UTEX The Culture Collection of Algae
at The University of Texas at Austin

Valicor Renewables

FLORIDA ALGAE, LLC

Commercial Algae Management, Inc.

ASU LightWorks

ASU
ARIZONA STATE UNIVERSITY

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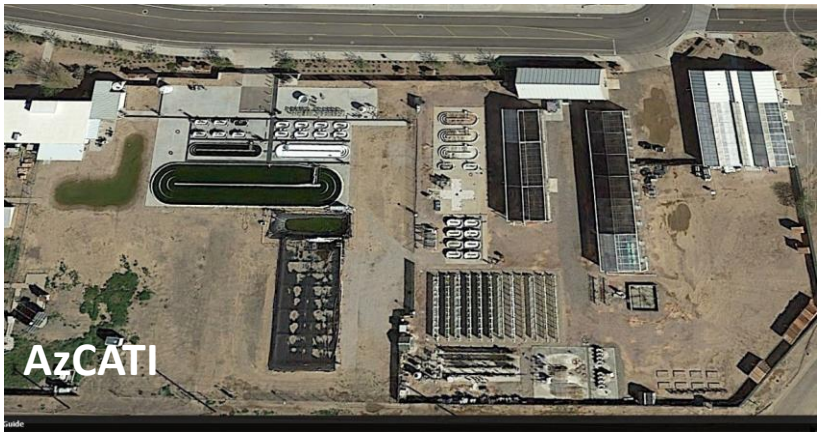
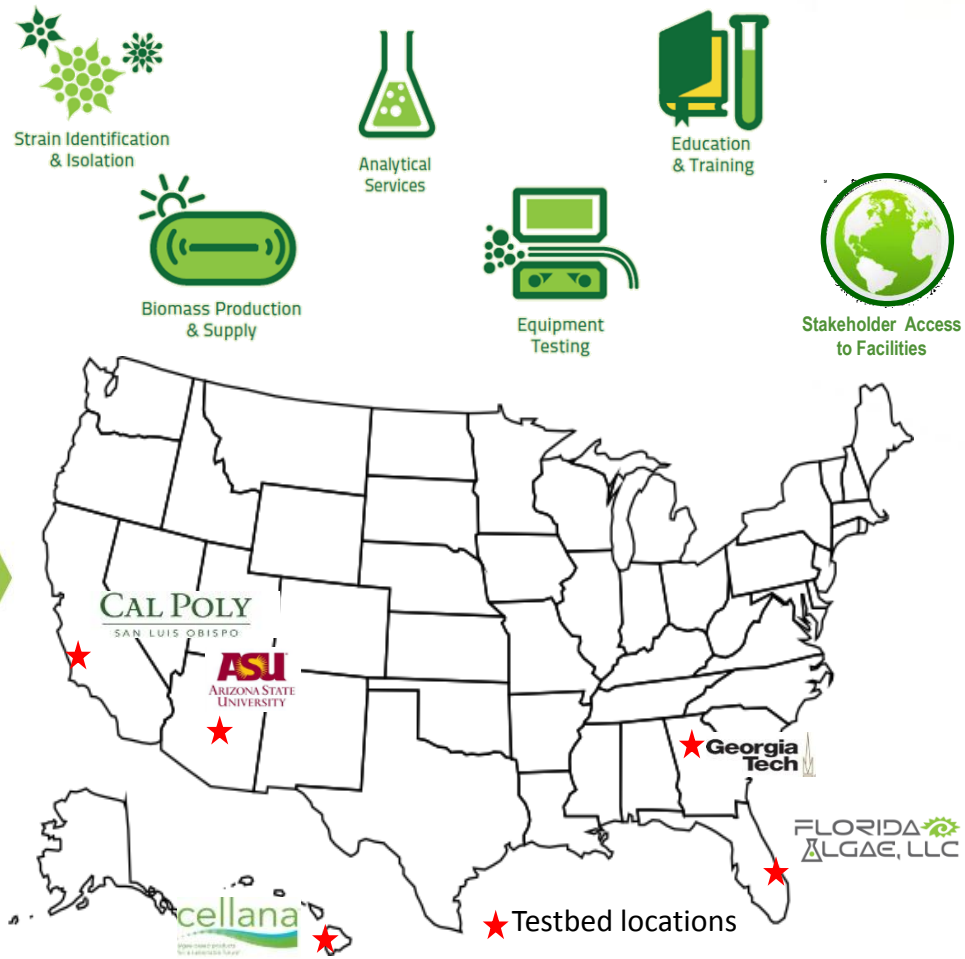
ATP³: National open test bed

The formation of the Algae Testbed Public-Private Partnership **leveraged** the existing resources at AzCATI and partner sites. The network represents a **collaboration** of industry, laboratory, and educational facilities across nation. ATP³ aims to **convene** all algae stakeholders to facilitate opportunities and progress more rapidly to commercialization..



Collaborative Open Testbeds

ATP³ offers access to a wide array of services, capabilities and facilities:



ATP³ Partner Site	Cultivation Capacity Total (Liters) (unit scale range)		Annual Production Capacity (AFDW)	Yr. Outdoor Operations Began
	Open Pond	Closed PBR		
ASU (AzCATI)	235,000 (200 - 125K)	21,000 (15 – 1500)	1.5 –2.0 MT	2006
Cellana (KDF)	750,000 (200 - 120K)	300,000 (20 – 24K)	12 – 15 MT	2008
Florida Algae	100,000 (500-30K)	200 (indoor only)	1.0 MT	2012
Cal Poly	100,000 (1000- 10K)	1200 (200-1000)	1.0- 1.5 MT	2007
Georgia Tech. (GT)	6000 (500-1000)	200 (indoor only)	< 0.1 MT*	2013
Total	**1,300,000 L**	**320,000L**	**15 – 20 MT**	

Regional testbed facilities for the partnership are physically located in **Arizona, Hawaii, California, Georgia, and Florida.**

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Why Engage with ATP³?

ATP^3: Testbeds Open for Business

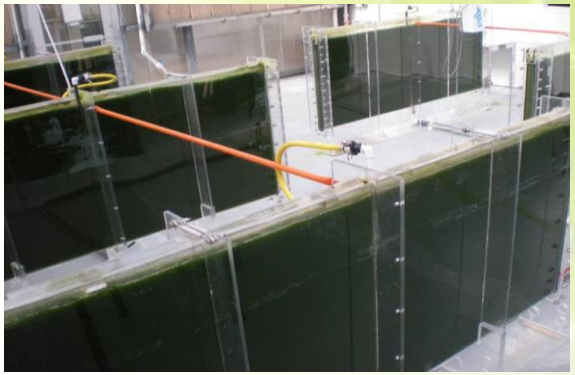
- ***Project Activities***: biomass supply, equipment testing, analytical testing, culture maintenance and consultation services to academia, industry and national labs

- ***Project Categories***: fee-for service activities, sponsored research, and subsidized projects through ATP^3 Support Program

- ***Project Benefits***: to drive technology research and development, de-risk and validate technological innovations

Cultivation options – AzCATI:

Platforms for indoor/outdoor experimentation



Variety of independent and vertically integrated downstream harvesting unit ops

Provide service to ATP^3 customers

- Produce algal biomass in the form of slurry, paste and dry powers
- Serve as baseline technologies for the improvement of future harvesting/dewatering and oil extraction processes (Valicor and OpenAlgae platforms)

Support DOE's TEA, sustainability, and resource modeling

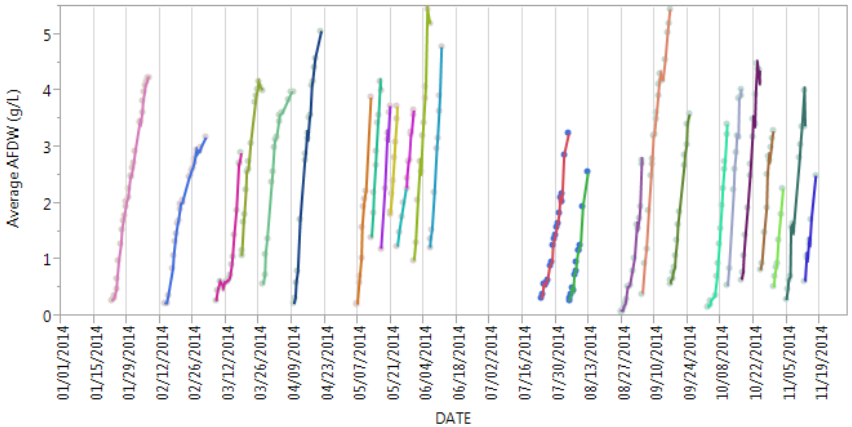
- Generate harvesting data for the current harmonized model
- Provide more options to generate data on the selection of harvesting methods
- Provide feedstock for lipid extraction and other downstream product applications



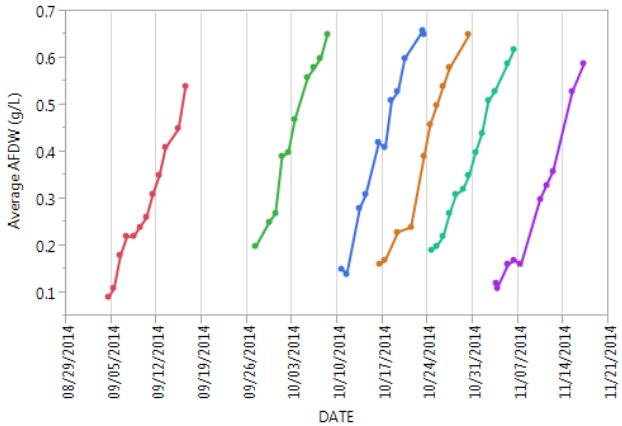



An Example: Biomass Toll Production Project

- **Leveraging the Helix™ photobioreactor**
  - Using the Helix as semicontinuous seed platform supporting larger scale cultivation in open pond raceways (2 x 60 m^2) of customer supplied proprietary strain
  - 8 week growth campaign generating 7-8 kg of biomass per batch (media recycle)
  - Total project duration 3 months (included indoor scale up)
  - ATP^3 delivered biomass as whole, freeze dried product.
  - Production data through harvest
    - centrifuge and MF -->centrifuge process options evaluated
    - can be utilized for TEA/LCA (with permission from client)



Helix Seed Production



60 m^2 cultivation campaign

Collaborative Open Testbeds: Site Access and Customer Management

ATP^3 offers a 3-tier fee structure

- Full data confidentiality (fully burdened rate – site specific)
- Open access -willing to share data generated at test bed (discounted)
  - level of discount site specific
- Subsidized Access (Scholarship and Innovators Awards)
  - Proposals for use of the testbed with access to materials, equipment, personnel
  - Travel support available to access sites (primarily for academics)

Site Access Plan: Boilerplate IP, MTA, NDA, and facilities use agreement in place for customers

- Simple templates for engagement – one off projects, longer term engagement, and engagement with facility use
- Academic unit approval only for external sales of services – **if no major changes requested, can be approved in ~1 week.**
- Can be applied as pass through to partner sites
  - AzCATI Recharge Center handles agreement and transaction and flows through funding to partner sites – only one party to negotiate with
- AzCATI has already been operating with this testbed framework for >3yrs
- Will transition to consortium based membership model as DOE funding decreases

ATP^3 Offers Support Program

The Goal – encourage and enable small businesses, entrepreneurs and underfunded academic researchers to pursue new approaches to solving technical issues associated with commercialization of algae biofuels, processes, and co-products.

What is it ?

- Access to laboratory, outdoor facilities and resource support for novel projects
- ATP^3 provides subsidized access to testbed facilities, technical expertise, and M&S
- Preference for support will be given to:
  - Short-term projects ranging from 1-3 months (typical project target $10K-$30K)
  - Researchers willing to share data and results widely through publication
  - Projects that leverage on-going activities already occurring (e.g., UFS/AFS)

Easy to start the process: Visit ATP3.org and fill out an expression of interest form

Initial cohort of support projects includes:

- Novel cultivars for flue gas capture (University of Delaware)
- Carbon management and delivery (LBNL)
- AD with LEA (Cal Poly)

Initial cohort of support projects includes:

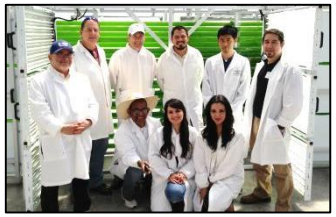
- Accepting applications for next cohort selection

Support may include:

- Biomass (whole, extracted, oil)
- Access to cultivation & downstream equipment (eq. transport, install/removal)
- Access to R&D, production & analytical expertise
- Access to laboratory and office space
- Travel stipends to testbed (currently limited to academic clients)

Education & Training Workshops

- ATP^3 has hosted 7 quarterly educational workshops
- Over 30 lecture modules
- Over 15 hands-on field site and laboratory activities
- Well attended by broad mix of academic and industrial participants
  - More than 200 participants representing >70 different organizations
- Most recent workshop: Large-Scale Cultivation and Downstream Processing (Nov 3-7th; Mesa, AZ)
- Compositional Analysis Workshop planned for May 2015 at NREL in Golden Colorado



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Summary

- The ATP^3 testbed network is up and running
- ATP^3 completed projects with >24 customers in 2 years
- Streamlined business processes – can be applied to multiple sites
- Six ongoing/scheduled projects
  - Includes non-US based foreign companies looking to leverage the network with a landing pad in the US
  - Cultivation trails (including GMO), analytical support, biomass (10's-100's kg), equipment trials, access to facilities to conduct your own R&D, training, etc…
- Three ATP^3 support projects have been accepted…two are well underway, 3 additional in pipeline for next year – looking for more
  - Great path to scale bench scale lab results (novel process ideas, strains (including GMO), out into the real world
  - New synergies/new collaborations
- Education and Training workshops have reached approximately 80 different agencies, organizations, companies and academic institutions

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Acknowledgements

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Todd Lane
Patricia Gharagozloo
Thomas Reichardt
Jessica Drewry
Pamela Lane

Cal Poly
Tryg Lundquist
Braden Crowe
Eric Nicolai

Commercial Algae Management
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Robert Vitale

Georgia Tech
Yongsheng Chen
Steven Van Ginkel
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Zixuan Hu

Cellana
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Kate Evans
Peter Prentiss
Reyna Javar
Kari Wolff
Keao Bishop-Yuan
Lynn Griswold
Christina Boyko
Charlie O'Kelley

Florida Algae
Steven Schlosser
Chris Withstandley
Mary Riddle
Nancy Pham Ho (FIT)

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Maria Bautista
Carlos Luna
Delaney De Hertogh
Shaylin Mcghee
Caden Offield

GT Undergrads
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Jerry Duncan
Frazier Woodruff
Shusuke Doi
Hao Fu
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Allison Dunbar
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Emily Wang
Jack Sunderland
Ann Marie Sequeira
Soroush Aboutalebi
Lauren Miller
Samantha Lui
Michele Hendrickson
Gabriella Campos
Will Briles
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